

## REPORT DOCUMENTATION PAGE

FORM APPROVED  
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of the collection of information, including suggestions for reducing the burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302 and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 96/02/12	3. REPORT TYPE AND DATES COVERED Qtly: Nov 95 - Jan 96	
4. TITLE AND SUBTITLE OF REPORT Quarterly Report #3 "Photonic Time Delay Beamforming for Aegis Radar"			5. FUNDING NUMBERS G: N00014-95-1-0988 R&T: 13xz002---01	
6. AUTHOR(S) Dr. Nabeel A. Riza, CREOL				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Office of Sponsored Research and Graduate Studies University of Central Florida -- ADM 243 4000 Central Florida Boulevard Orlando, FL 32816-0150			8. PERFORMING ORGANIZATION REPORT NUMBER:	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Dr. William Micheli, Program Manager/Officer, ONR:313 Office of Naval Research 800 North Quincy Street Arlington, VA 22217-5660			10. SPONSORING/MONITORING AGENCY REPORT NUMBER:	
11. SUPPLEMENTARY NOTES:			19960812 183	
12a. DISTRIBUTION AVAILABILITY STATEMENT Approved for public release - distribution is unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)  CREOL moved into its dedicated \$20M facility on the campus of the University of Central Florida. Dr. Riza established CREOL's first Photonic Information Processing Systems Laboratory in the new CREOL Building. CREOL has made good progress on experimentally evaluating the fiber-optic interconnect issued related to our Aegis photonic beamformer. In particular, we have experimentally evaluated the use of fiber-to-fiber optical coupling using single-mode fibers, GRIN rod lenses, and imaging lenses. Previously, we experimentally showed that an inter-fiber gap distance of 5 cm or less is necessary to prevent high (e.g. 5 dB or higher) optical loss when no loss preventing optics is used between the fibers. Our new experiments using imaging lenses between the fiber ports demonstrate the key factors that are important for reducing coupling loss. Main experimental conclusions are outlined in report. CREOL has also starting looking at the fiber array design and packaging issues. Using GRIN-fiber lenses, we have concluded that a hexagonal array geometry for fiber packing provides the highest channel packing density. Lockheed-Martin Lab-Syracuse has recently provided CREOL with preliminary Navy Aegis radar time delay unit electrical specs. We are developing the optical specs based on that data.				
14. SUBJECT TERMS			15. NUMBER OF PAGES: 2	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT: UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT SAR	



Sponsored Research

June 12, 1996

Defense Technical Information Center (DTIC)  
8725 John J. Kingman Road  
Suite 0944  
Fort Belvoir, VA 22060-6218

Re: ONR Grant # **N00014-95-1-0988**  
Entitled "Photonic Time Delay Beamforming for Aegis Radar"  
UCF Account # 65-03-309

Dear Sir or Madame:

Attached is the Quarterly Progress Report along with the SF298 form requested by Ms. Cynthia Sloan of the Atlanta ONR office.

If you have any questions, please call me at (407) 823-2836. Thank you for your assistance.

Sincerely,

A handwritten signature in black ink, appearing to read 'Betsy L. Gray'.

Betsy L. Gray  
Award Administrator

cc: Ms. Cynthia R. Sloan, Administrative Grants Officer, ONR, Atlanta, GA (SF298 only)  
Dr. Nabeel A. Riza, CREOL (SF298 only)  
Mr. Thomas P. O'Neal, CREOL (SF298 only)  
Mr. Mark Wagenhauser, CREOL (SF298 only)

File: Riza (A/C# 65-03-309)

**DTIC QUALITY INSPECTED 1**

To

Dr. William Miceli (ONR Program Monitor)

Office of Naval Research

Ballston Tower One

800 North Quincy Street

Arlington, Virginia 22217-5660

Grant No: N00014-95-1-0988

Grant Title: Photonic Time Delay Beamforming for Aegis Radar

Dated Feb.12, 1996.

Quarterly Progress Report 3:

From

Dr. Nabeel A. Riza (Principal Investigator)

CREOL-University of Central Florida-Orlando

**Progress Report:**

1. Over Dec. 95 and Jan.96, CREOL has moved to its dedicated \$ 20 M facility on the campus of the University of Central Florida. I have established **CREOL's first Photonic Information Processing Systems Laboratory** in the new CREOL Bldg. Our labs are located in 3 separate rooms on the second floor of the Bldg. These labs have been named:

(a) Signal Analysis Systems Laboratory,

(b) Control Systems Laboratory, and

(c) Communication Systems Laboratory.

There is also a separate Computer Room. In early April, 96, CREOL will have its formal ribbon cutting ceremony.

2. CREOL has made good progress on experimentally evaluating the fiber-optic interconnect issues related to our Aegis photonic beamformer. In particular, we have experimentally evaluated the use of fiber-to-fiber optical coupling using single-mode fibers, GRIN rod lenses, and imaging lenses. Previously, we experimentally showed that an inter-fiber gap distance of 5 cm or less is necessary to prevent high (e.g., 5 dB or higher) optical loss when no loss preventing optics is used between the fibers. Our new experiments using imaging lenses between the fiber ports demonstrate the key factors that are important for reducing coupling loss. The main experimental conclusions are:

~~19960315 070~~

(a) Imaging lens aberrations limit the ultimate uniformity of the light over the N output fiber channels. A worst case maximum optical signal variation of 0.55 dB was obtained between the center and 9th channel (located at 14.4 mm from the center). This measured optical variation is small, and can be further improved with higher quality lenses.

(b) By using these imaging lenses with the GRIN-fiber assemblies, the optical channel to channel crosstalk between two adjacent channels is below the measurement range ( $< -60$  dB) when the GRINs are placed side-to-side (i.e., inter-channel gap is 1.8 mm). When the inter-channel gap is smaller, i.e., 0.9 mm, we measured a -56 dB optical crosstalk level. These results indeed show that imaging lens play a critical role is minimizing crosstalk.

(c) Input-Output port separation misalignment along the optic axis is NOT a critical loss factor. Experimentally, we showed that for a 5 % separation misalignment error, the measured optical loss was very small, i.e.,  $< 0.1$  dB. This means, optic axis separation misalignment is not a critical loss factor.

(d) The relative angular tilt misalignment between the input-output port GRIN assemblies was experimentally determined to be critical as a loss factor. Experimentally, we showed that a small angle misalignment error of less than 0.1 degrees is required for an optical loss of  $< 5$  dB.

3. CREOL has also starting looking at the fiber array design and packaging issues. Using GRIN-fiber lenses, we have concluded that a hexagonal array geometry for fiber packing provides the highest channel packing density.

4. Lockheed-Martin Lab-Syracuse has recently provided CREOL with some preliminary Navy Aegis radar time delay unit electrical specifications. CREOL is developing the optical specifications based on the LM provided data. Initial data indicates requiring a 7-bit time delay unit over a 3 to 6 GHz frequency range.

5. Future work at CREOL will include generating Aegis radar time delay unit optical requirements, and Displaytech ferroelectric liquid crystal switch evaluation.

P.S. Please see attached viewgraphs for technical details. The computer disk contains the appropriate viewgraphs for your future use.